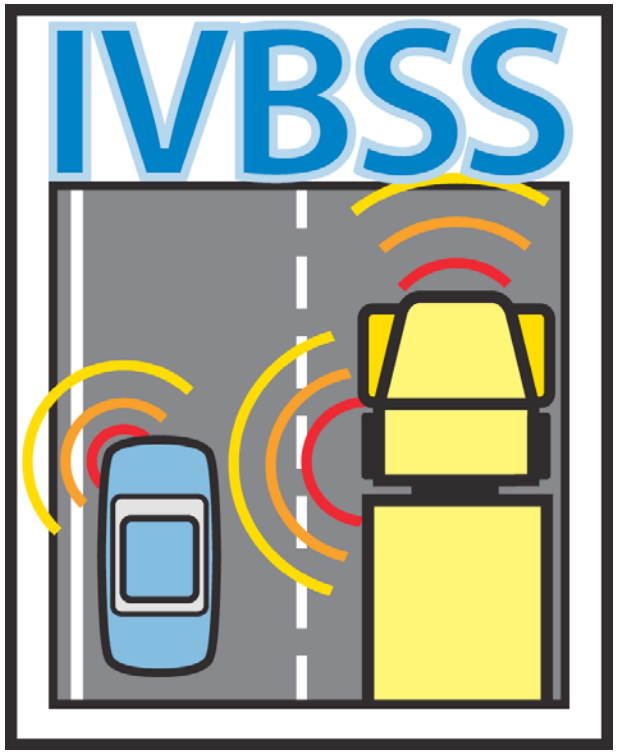


Heavy-Truck System Development

Zhijun “Zwick” Tang, PhD
Eaton Corporation

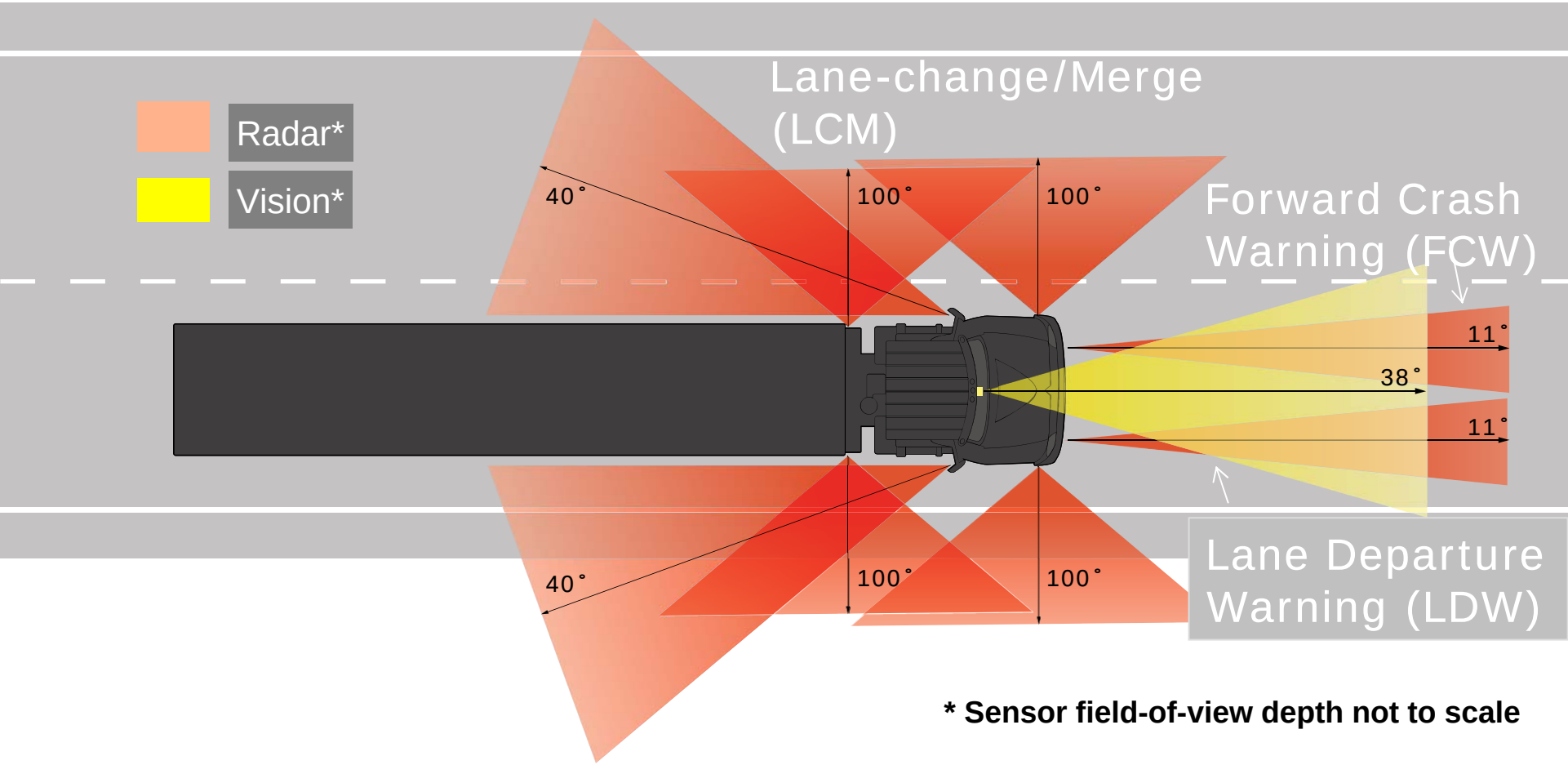
2008 ITS World Congress
Session AM36

November 19, 2008

Outline

- System overview
- Year 3 progress summary
- Key developments
- Field Operational Test vehicle integration status
- Next steps

Integrated Safety System

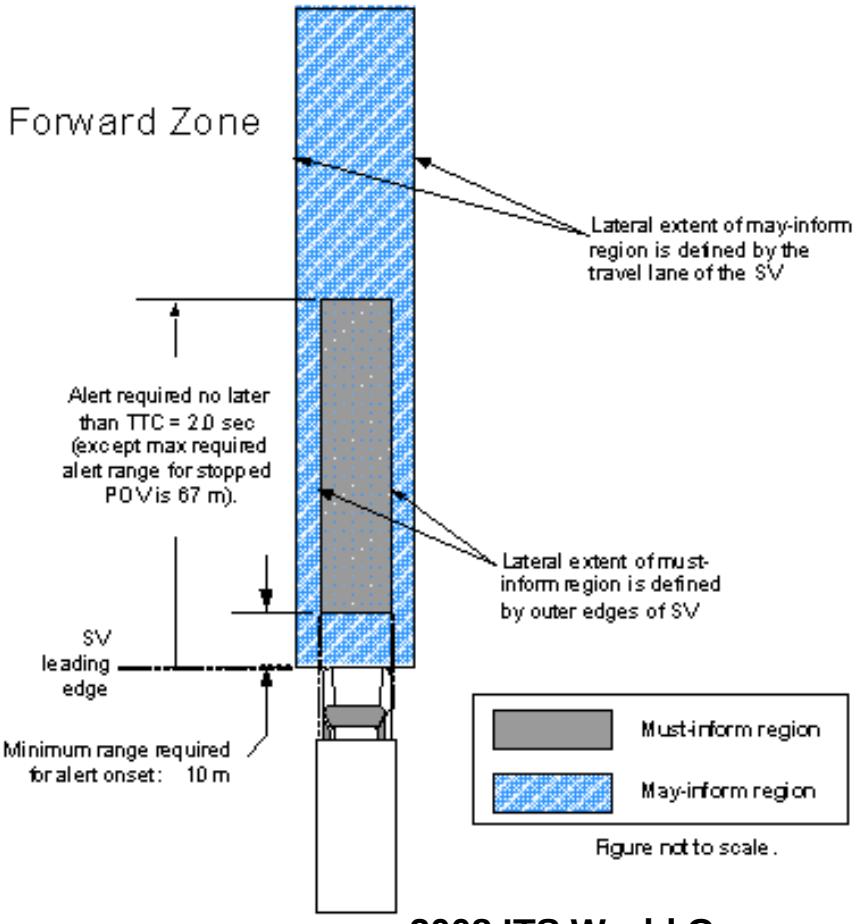


*** Sensor field-of-view depth not to scale**

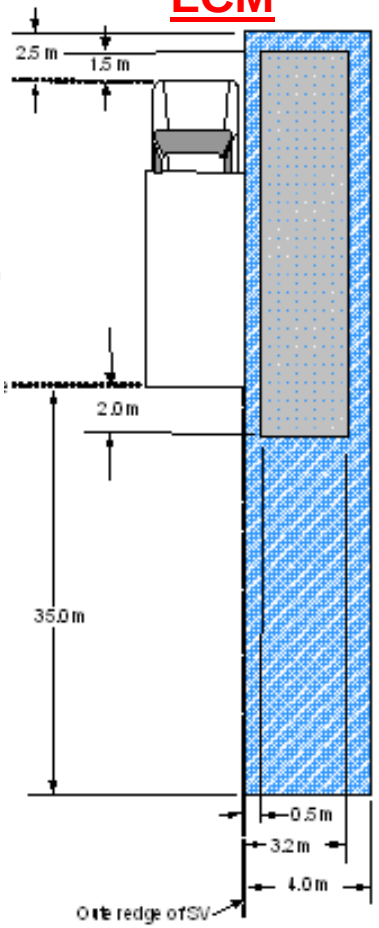
Sensor Suite

Warning Zones

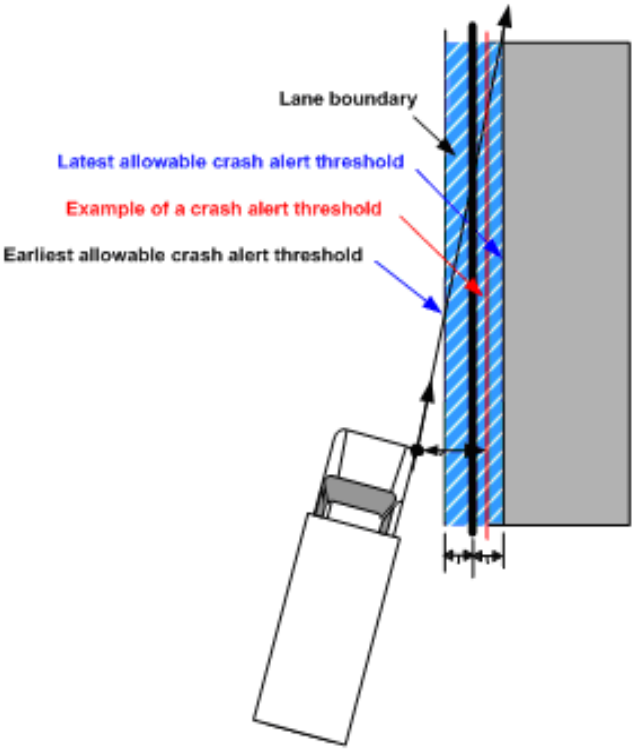
FCW



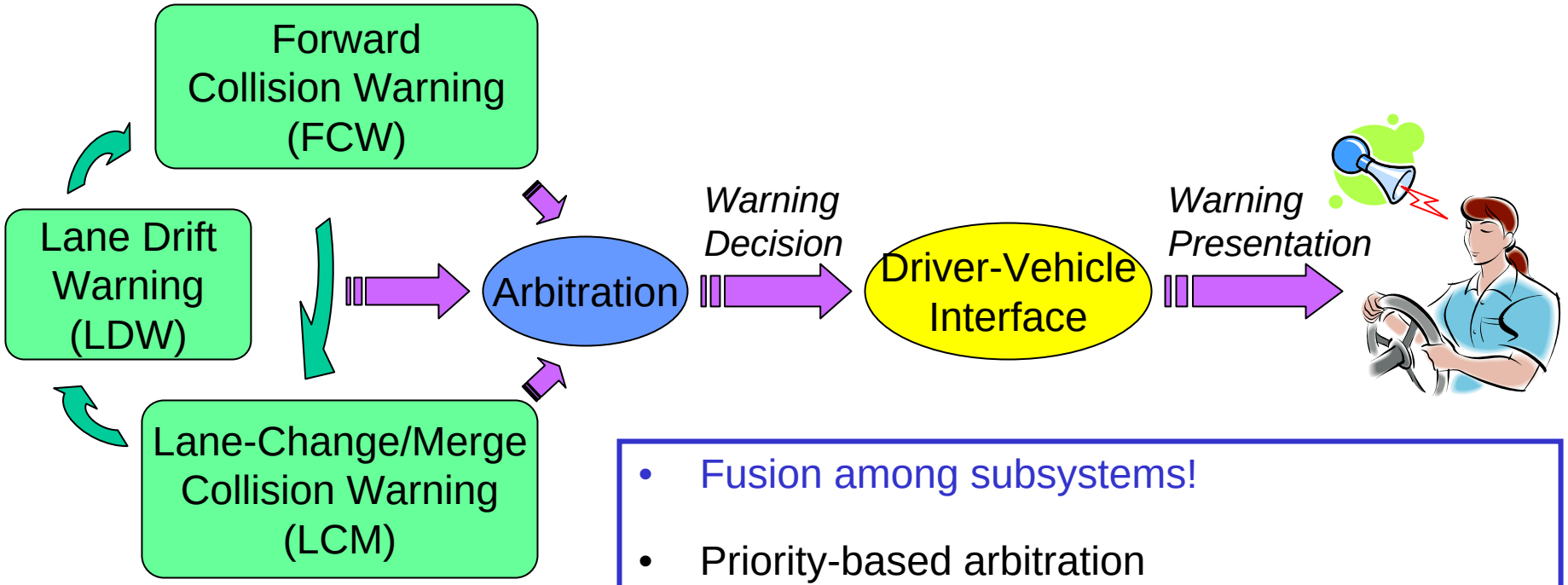
LCM



LDW



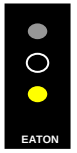
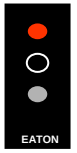
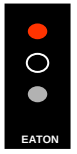
System Architecture

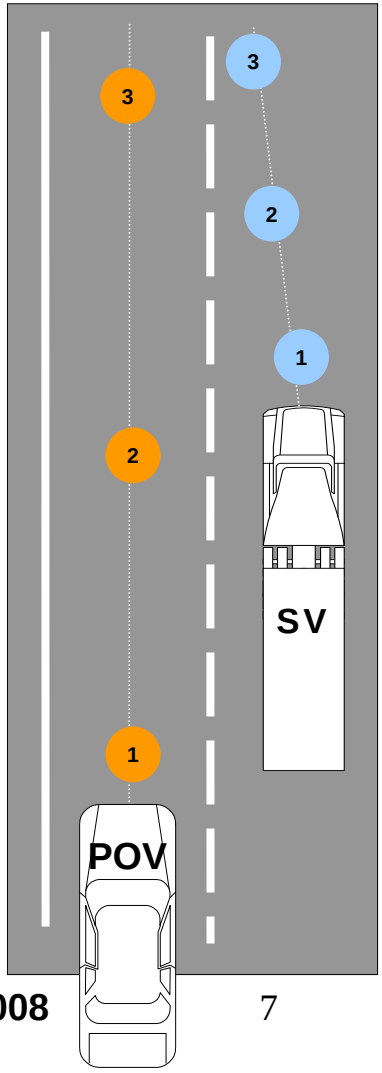


- Fusion among subsystems!
- Priority-based arbitration
  - At most one auditory alert to the driver in any moment
- Multi-level, directional driver-vehicle interface
  - Visual + audible, central + side

Example

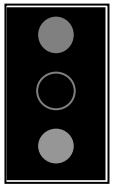
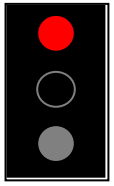
- LCM: Lane-change into an approaching POV

Scenario	Local Decision	Arbitration	Implementation
(1) Other vehicle enters Adjacent Zone	Advisory Alert		Level-1 Side-display 
(2) SV turns on the turn signal but no lane change yet	Advisory Alert		Level-2 Side-display 
(3) SV changes lanes	Audible Alert	- Higher level alert? - Low risk?	Audible collision alert 

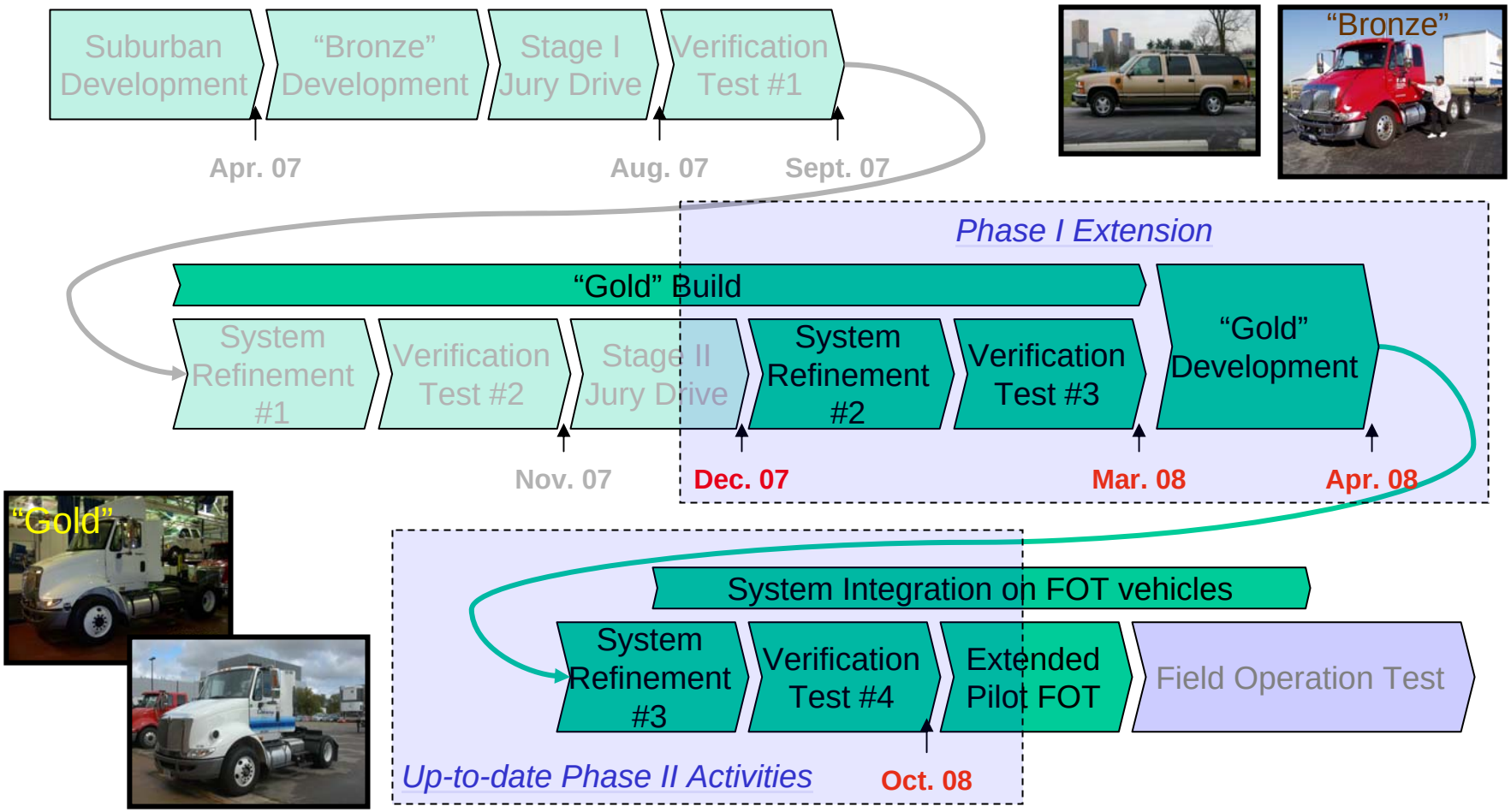


Driver-Vehicle Interface

Examples of DVI Operation

Cond. Code	Initiation Condition	Visual Displays Side	Visual Displays Forward	Auditory Display (Directional)
FCW-3	Forward object within 2s headway	N/A		Opening=None Closing=Short Alert
FCW-6	Slower moving vehicle in the front	N/A		Repeating Alert
LDW-1	Subject vehicle drift just outside the lane boundary toward an unoccupied lane			Directional lane excursion warning
LCM-3	Adjacent vehicle detected AND lane change maneuver IS detected		N/A	Right/Left channel side collision warning

Summary of Progress in Year 3



Major System Development during Phase I Extension

- Software improvement:
  - Lane Change/Merge false alert mitigation
    - Vehicles in opposite direction
    - Roadside stationary objects
    - Vehicles in one-lane-over
  - Lane Departure Warning false alert mitigation
  - Unnecessary alert suppression at the arbitration level
    - Alerts at low-risk situations (e.g. low speed, recent brake application)
- Driver-vehicle interface improvement
  - Revisit the sound choice based on drivers' feedback
- "Gold" truck development:
  - Migration of the prototype system to a platform that represents field operation test vehicles

Main System Development in Phase II

- Hardware changes:
  - Revised sensor mounting with improved robustness and durability
- Software changes:
  - Automatic trailer reflection learning
  - Additional false alert mitigation against Lane Change/Merge warnings toward fast-overtaking vehicles in the adjacent lane
  - Argument of system diagnostics information
  - Lane Departure Warning subsystem fine-tune with the addition of automatic fault alert detection/suppression
  - Revised driver-vehicle interface
    - New LCM sound
    - Trailer configuration input
    - Pre-emption logic for multiple alerts

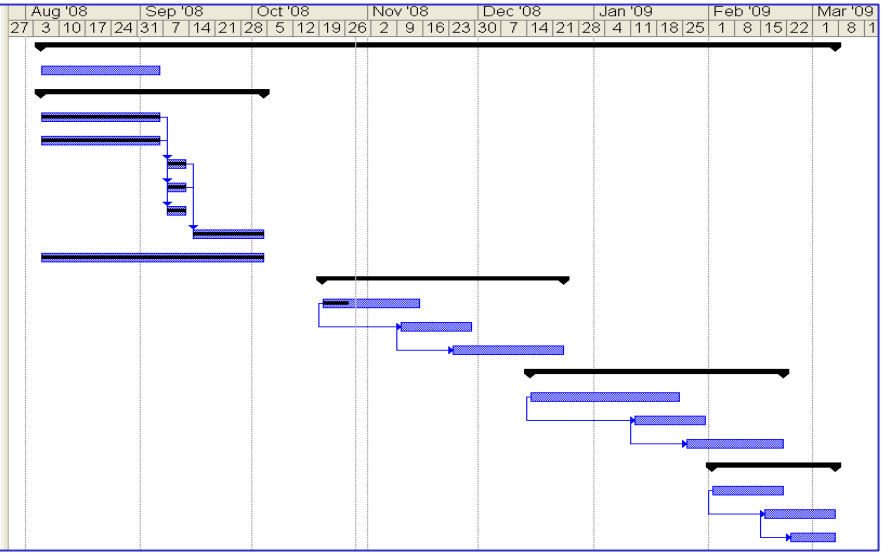
FOT Vehicle Integration Status

- The first FOT vehicle (FOT 1) integration completed
- FOT 2-4 integration in progress – expected to be completed by mid Dec. 2008
- FOT 5-8 to be ready for system integration in mid Nov. 2008 – expected to be completed by the end of Jan. 2009

»

- FOT 9-10 to be ready for system integration in mid Dec. 2008 – expected to be completed by early Mar. 2009

	Task Name	Start	Finish
201	**FOT build**	**Tue 8/5/08**	**Fri 3/6/09**
202	Fabricate components	Tue 8/5/08	Fri 9/5/08
203	**FOT #1 Build**	**Tue 8/5/08**	**Fri 10/3/08**
204	Hardware Installation	Tue 8/5/08	Fri 9/5/08
205	Electronic & mechanic check-out	Tue 8/5/08	Fri 9/5/08
206	Sensor alignment and calibration	Mon 9/8/08	Fri 9/12/08
207	Software installation and check-out	Mon 9/8/08	Fri 9/12/08
208	DAS installation and check out	Mon 9/8/08	Fri 9/12/08
209	Mileage accumulation and software calibration	Mon 9/15/08	Fri 10/3/08
210	Trouble shooting&Debug	Tue 8/5/08	Fri 10/3/08
211	**FOT #2~#4 Build**	**Mon 10/20/08**	**Tue 12/23/08**
212	Roush installation	Mon 10/20/08	Fri 11/14/08
213	Check-out and debug	Mon 11/10/08	Fri 11/28/08
214	Mileage accumulation and software calibration	Mon 11/24/08	Tue 12/23/08
215	**FOT #5~#8 Build**	**Mon 12/15/08**	**Fri 2/20/09**
216	Roush installation	Mon 12/15/08	Fri 1/23/09
217	Check-out and debug	Mon 1/12/09	Fri 1/30/09
218	Mileage accumulation and software calibration	Mon 1/26/09	Fri 2/20/09
219	**FOT #9~#10 Build**	**Mon 2/2/09**	**Fri 3/6/09**
220	Roush installation	Mon 2/2/09	Fri 2/20/09
221	Check-out and debug	Mon 2/16/09	Fri 3/6/09
222	Mileage accumulation and software calibration	Mon 2/23/09	Fri 3/6/09



Next Steps

- Extended Pilot FOT
- Continue system integration and calibration on FOT vehicles
- System refinement based on the results and feedback from the Extended Pilot FOT
- Continue FOT preparation